AIR CONDITIONER FOR AUTOMOBILES
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1.   Title of the Invention: AIR CONDITIONER FOR AUTOMOBILES

2.   Claim

An air conditioner for automobiles characterized by the fact
that the inside of an air duct at the downstream of an evaporator is
divided into two by a partition plate and separated into a right air
duct and a left air duct; temperature regulation mechanisms
consisting of an air mixing damper and a heater core are respectively
disposed in said left and right air ducts; various kinds of blow-off
ports for blowing off an air-conditioned air to a driver's seat are
opened at the lowermost flow end of the right air duct; various kinds
of blow-off ports for blowing off an air-conditioned air to an
assistant's seat are opened at the lowermost downstream end of the
right air duct; and it is equipped with an external air sensor that
detects an external air temperature, an internal gas sensor that
detects a vehicle inside temperature, a solar radiation sensor that
detects the amount of solar radiation into a vehicle room, a
temperature setter that sets an air-conditioning set temperature in
the vehicle, and an arithmetic control circuit that attains a target
blow-off temperature for obtaining the above-mentioned air-

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*Numbers in the margin indicate pagination in the foreign text.

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conditioning set temperature based on the above-mentioned external air temperature, temperature in the vehicle room, and amount of sun radiation, sets the degree of opening of the air mixing damper in the above-mentioned right air duct for adjusting the blow-off temperature at the driver's seat so that the blow-off temperature may be lower than the above-mentioned target blow-off temperature by 1/2 of the above-mentioned target blow-temperature difference ΔT in order to set the blow-off temperature at the driver's seat lower than the blow-off temperature at the assistant's seat by ΔT, and sets the degree of opening of the air mixing damper in the above-mentioned right air duct for adjusting the blow-off temperature at the assistant's seat so that the blow-off temperature may be higher than the above-mentioned target blow-off temperature by 1/2 of the above-mentioned target blow-temperature difference ΔT.

3. Detailed explanation of the invention

The present invention pertains to an air conditioner for automobiles, and its purpose is to provide an air conditioner that can set a blow-off temperature at a driver's seat so that it /2 may be lower than the blow-off temperature at an assistant's seat by a desired temperature and can blow off an air.

In conventional air conditioners for automobiles, it is usual to blow off an air-conditioned air at the same temperature from left and air blow-off ports of a driver's seat and an assistant's seat. However, for a driver in a tense state due to the concentration of nerves on the driving operation, it is desirable in terms of vehicle

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safety to blow off an air-conditioned air at a temperature slightly lower than that of a passenger of the assistant's seat. In case an air-conditioned air at the same left and right temperature is blown off like the conventional air conditioners, a considerable difference is generated in the blow-off temperature of blow-off ports at a driver's seat and an assistant's seat by the variation of the flow velocity distribution of the air in the vicinity of a heater core due to the position of an air mixing damper, the state of the heating water distribution in the heater core, etc.. The level of the temperature difference is totally irregular, and the blow-off temperature at the driver's seat is raised or the blow-off temperature at the assistant's seat is raised in accordance with the position of the air mixing damper. Thus, the driver's seat could not always be set to a temperature lower than that of the assistant's seat by a desired temperature.

The present invention solves the above-mentioned problems by adopting an air conditioner for automobiles with the constitution described in the patent claim range and provides an air conditioner for automobiles that can set a blow-off temperature at a driver's seat so that it may be lower than the blow-off temperature at an assistant's seat by a desired temperature and can blow off an air.

Next, referring to the figures, the constitution of the present invention is explained.

Figure 1 shows the constitution of the air conditioner for automobiles of the present invention. At the tip at the upstream of an air duct, an external air intake port 2 for introducing an air

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outside a vehicle and an internal air intake port 3 for introducing an air in a vehicle room are installed. These intake ports 2 and 3 can be selectively switched by an external air switching damper 4. Right behind the downstream of the intakes 2 and 3, a fan 5 for blowing off the air absorbed from these intake ports 2 and 3 is installed, and the fan 5 is rotated by a fan motor 6. At the downstream of the fan 5, an evaporator 7 being a heat exchanger for air conditioning is installed and constitutes a freezing cycle along with compressor, condenser, etc., not shown in the figure. Furthermore, at the downstream of said evaporator 7, a partition plate 8 for dividing the inside of the air duct 1 into two is internally inserted, and the inside of the air duct 1 is separated into a right air duct 9 and a left air duct 10.

In these left and right air ducts 9 and 10, each temperature regulation mechanism is disposed. The temperature regulation mechanism at the right air duct 9 consists of an air mixing damper 11 for dividing an air flow flowing through the right air duct 9 into two and a heater core 12 being a heat exchanger for heating which heats one of the branched air flows. The air flow, which is branched by the partition plate 8 and flows from the upstream in the right air duct 9, is branched into a first air flow being heated through the heater core 12 and a second air flow which bypasses the heater core 12 and re-joined and mixed at the downstream of the air mixing damper 11, so that the blow-off temperature is regulated. In other words, the blow-off temperature of the right air duct is freely controlled by changing the degree of opening of the air mixing damper 11 and

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adjusting the distribution ratio of the above-mentioned first and second air flows. Also, the temperature regulation mechanism of the left air duct 10 consists of an air mixing damper 13 and a heater core 12, and similarly to the above-mentioned right air duct 9, the blow-off temperature of the left air duct is freely controlled by changing the degree of opening of the air mixing damper 13 and adjusting the distribution ratio of the air flows. Also, in the example shown in the figure, one wide core which crosses the left and right air ducts 9 and 10 is used in the heater core 12, and, and the respective left and right segments of the core are discriminated and used as each heater core for an air duct. An engine coolant not shown in the figure is supplied in a circulatory type as a heater heat source to the heater core 12.

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The above-mentioned air mixing damper 11 is independently opened and closed by a damper actuator 14, and the air mixing damper 13 is independently opened and closed by a damper actuator 15. These damper actuators 14 and 15 are respectively separately instructed and controlled by an arithmetic control circuit 16 that will be mentioned later.

At the lowermost downstream position of the right air duct 9 of the air duct 1, heater blow-off port 17, vent blow-off port 18, and defroster blow-off port 19 for a driver's seat side (right side) for blowing off an air-conditioned air into a vehicle room are respectively opened. These blow-off ports 17, 18, and 19 are respectively selectively opened and closed by dampers 20 and 21.

Similarly, at the lowermost downstream position of the left air

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duct 10 of the air duct 1, heater blow-off port 22, vent blow-off port 23, and defroster blow-off port 24 for an assistant's seat side (left side) are respectively opened, and these blow-off ports 22, 23, and 24 are respectively selectively opened and closed by dampers 25 and 26. The dampers 20 and 25 are coaxially supported, and the dampers 21 and 26 are coaxially supported. They are respectively opened and closed by damper actuators 27 and 28 for rotating each support shaft. Therefore, the left and right heater blow-off ports 17 and 22, left and right vent blow-off ports 18 and 23, and left and right defroster blow-off ports 19 and 24 are respectively simultaneously closed or opened. The above-mentioned damper actuators 27 and 28 are instructed and controlled by the arithmetic control circuit 16 that will be mentioned later.

The above-mentioned left and right heater blow-off ports 17 and 22 are generally installed below an instrument panel of a vehicle, and a heating air is blown off to the foots of the leaf and right seating passengers. Also, the above-mentioned left and right vent blow-off ports 18 and 23 are generally installed at the left and right of the front of the instrument panel and blows off an air-conditioned air to the upper part of the body of the passenger at the driver's seat and the passenger at the assistant's seat. These heater blow-off ports 17 and 22 and vent blow-off ports 18 and 23 are selectively opened and closed by the dampers 20 and 25.

Also, the above-mentioned left and right defroster blow-off ports 19 and 24 blow off the air to the front window of an automobile not shown in the figure and realizes a window defrost. The defroster

blow-off ports 19 and 24 are selectively opened and closed by the dampers 21 and 26 or partially opened.

The arithmetic control circuit 16 is a circuit that controls the respective damper actuators 14, 15, 27, and 28 according to the instruction from a temperature setter 29 and controls a fan motor speed controller 30 for rotating the fan motor 6. A microcomputer is generally used.

The temperature setter 29 is installed in an air-conditioning control panel in the vehicle room and sets an air-conditioning set temperature T_{SET} in the vehicle room and a blow-off temperature difference ΔT of the left and right blow-off ports. /4

In the above-mentioned arithmetic control circuit 16, T_o, T_r, and ST signals are respectively input from an external air sensor 31 for detecting an external air temperature T_o, an internal air sensor 32 for detecting a temperature T_r in the vehicle room, and a solar radiation sensor 33 for detecting an amount ST of solar radiation into the vehicle room. The arithmetic control circuit 16 receives the external air temperature T_o, the temperature T_r in the vehicle room, and the amount ST of solar radiation and calculates a target blow-off temperature T_A for maintaining the vehicle room inside at the above-mentioned air-conditioning set temperature T_{SET} according to the following equation (1).

$$T_A = K_1 \cdot T_{SET} - K_2 \cdot T_o - K_3 \cdot T_r - K_4 \cdot ST + C \qquad (1)$$

(However, K_1-K_4 and C are constants.)

Next, the target blow-off temperature T_{AR} of the right blow-off port

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being a blow-off port at the driver's seat and the target blow-off

temperature T_{AL} of the left blow-off port being a blow-off port at

the assistant's seat are respectively calculated according to the

following equations (2) and (3).

$$T_{AR} = T_A - \Delta T/2 \qquad\qquad (2)$$

$$T_{AL} = T_A + \Delta T/2 \qquad\qquad (3)$$

(However, ΔT is a desired temperature difference of the left

and right blow-off ports.)

After T_{AR} and T_{AL} are attained from the above-mentioned equations (2)

and (3), the arithmetic control circuit 16 gives damper opening

degree signals corresponding to T_{AR} and T_{AL} to the damper actuators 14

and 15 for opening and closing the air mixing dampers 11 and 13 so

that the blow-off temperature at the driver's seat and at the

assistant's seat may be respectively T_{AR} and T_{AL} and moves the air

mixing dampers 11 and 13 to opening degree positions for giving the

above-mentioned T_{AR} and T_{AL}.   Also, the arithmetic control circuit 16

calculates an optimum fan speed corresponding to the above-mentioned

target blow-off temperature T_A and outputs a control signal based on

the result to the fan speed controller 30.

The fan speed controller 30 consists of well-known devices such

as variable resistor and pulse speed controller and controls the fan

motor 6 based on the control signal being input from the arithmetic

control circuit 16 so that the fan 5 may have an optimum air blow fan

speed.   Figure 2 shows an example of a characteristic curve showing

the relationship between the target blow-off temperature T_A and the

fan motor voltage V_1 for giving an optimum fan speed.   The

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relationship between T_A and V_1 is shown by the following equation (4).

$$V_1 = F(T_A) \qquad (4)$$

(However, F(x) represents a function.)

The device of the present invention with the above-mentioned constitution is operated as follows, and an air-conditioning state having a desired temperature difference ΔT in the left and right blow-off temperatures is realized.

First, the arithmetic control circuit 16 reads the external air temperature T_o, the temperature T_r in the vehicle room, and the amount ST of solar radiation detected from the external air sensor 31, internal air sensor 32, and solar radiation sensor 33 and calculates the target blow-off temperature T_A based on the above-mentioned equation (1).

Then, the target blow-off temperature T_{AR} of the right blow-off port being a blow-off port at the driver's seat nd the target blow-off temperature T_{AL} of the left blow-off port being a blow-off port at the assistant's seat are calculated by the above-mentioned equations (2) and (3).

Next, the damper opening degrees (damper positions) of the air mixing damper 11 for the right side and the air mixing damper 13 for the left side are calculated so that the blow-off temperature of the right blow-off port and the blow-off temperature of the left blow-off port may be the above-mentioned target blow-off temperatures T_{AR} and T_{AL}, respectively. Now, if the damper opening degree of the right air mixing damper 11 is S_R and the damper opening degree of the left

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air mixing damper 13 is S_L, the damper opening degrees can be attained from the following equations.

$$S_R = G_1(T_{AR}) \tag{5}$$

$$S_L = G_2(T_{AL}) \tag{6} \quad /5$$

Also, the detailed function types of $G_1(x)$ and $G_2(x)$ are determined by the shape, structure, etc., of the air duct 1.

The arithmetic control circuit 16 attains the above-mentioned damper opening degrees S_R and S_L and outputs instructions to the damper actuator 14 for the right side and the damper actuator 15 for the left side and sets the air mixing damper 11 for the right side to the damper opening degree S_R and the air mixing damper 13 for the left side to the damper opening degree S_L, respectively. Furthermore, the arithmetic control circuit 16 gives a control signal to the fan speed controller 30 so that the fan 5 may be rotated at an optimum fan speed corresponding to the target blow-off temperature T_A. Thus, the fan speed controller 30 applies the fan motor voltage V_1 according to the equation (4) (see the characteristic curve of Figure 3) to the fan motor 6 and controls the fan 5 at an optimum fan speed at that time.

As a result of the above control, the air of the blow-off temperature $T_{AR} = T_A - \Delta T/2$ is blown to the driver from the right blow-off port, for example, the right vent blow-off port 18, and the air of the blow-off temperature $T_{AL} = T_A + \Delta T/2$ is blown to the assistant from the left vent blow-off port 23 being a left blow-off port, so that the driver's seat side is always suppressed to the blow-off temperature lower than that of the assistant's side by the

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set temperature difference ΔT. Needless to say, the temperature difference ΔT can be freely changed to a desired value, and ΔT may also always be automatically set as a fixed value from the beginning instead of inputting from the temperature setter 29.

A flow chart of the above-mentioned operation is shown in Figure 3.

Also, in the above-mentioned operation explanation, the blow-off temperature T_{AR} of the blow-off port at the driver's seat and the blow-off temperature T_{AL} of the blow-off port at the assistant's seat has been $T_{AL} - T_{AR} = \Delta T$, however if $\Delta T = 0$, the left and right same blow-off temperature can also be simply set similarly to the conventional air conditioners. In the conventional air conditioners, since the air mixing damper has been one unit, there is a difference in the blow-off temperature between the driver's seat and the assistant's seat due to the flow velocity distribution of the air in the vicinity of the temperature regulation mechanism, etc., and the temperature difference is increased at the driver's seat or at the assistant's seat with the change of the degree of opening of the air mixing damper. However, according to the device of the present invention, when $\Delta T = 0$ is set, even if the degree of opening of the air mixing dampers is changed, the blow-off temperature at the driver's seat and at the assistant's seat can be accurately set.

Since the present invention has the above-mentioned constitution and operation, the driver, who requires an air-conditioning temperature slightly lower than that of the passenger of the assistant's seat due to the use of nerves in driving, can be set

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to a blow-off temperature lower than the blow-off temperature at the assistant's seat by a desired temperature, and each pleasant air-conditioning state can be realized at the driver's seat and at the assistant's seat. Also, according to the present invention, the blow-off temperature at the driver's seat is prevented from being higher than the blow-off temperature at the assistant's seat or the blow-off temperature at the assistant's seat is prevented from being higher than the blow-off temperature at the driver's seat due to the change of the degree of opening of the air mixing dampers during the air conditioning control. Thus, a required air-conditioning state can be accurately realized and maintained.

4. Brief description of the figures

Figure 1 is a constitutional diagram showing the air conditioner for automobiles. Figure 2 is a characteristic diagram showing the relationship between a target blow-off temperature and a fan motor voltage. Figure 3 is a flow chart /6 showing the operation of the device of the present invention.

1   Air duct

5   Fan

6   Fan motor

7   Evaporator

8   Partition plate

9   Right air duct

10   Left air duct

11   Air mixing damper

13

12   Heater core

13   Air mixing damper

16   Arithmetic controller

17, 22   Left and right heater blow-off ports

18, 23   Left and right vent blow-off ports

19, 24   Left and right defroster blow-off ports

30   Temperature setter

31   External air sensor

32   Internal air sensor

33   Solar radiation sensor

T_o External air temperature

T_r Temperature in a vehicle room

ST   Amount of solar radiation

T_{SET} Air-conditioning set temperature

ΔT Blow-off temperature difference of the left and right blow-off

ports

T_A Target blow-off temperature

T_{AR} Blow-off temperature of the right blow-off port

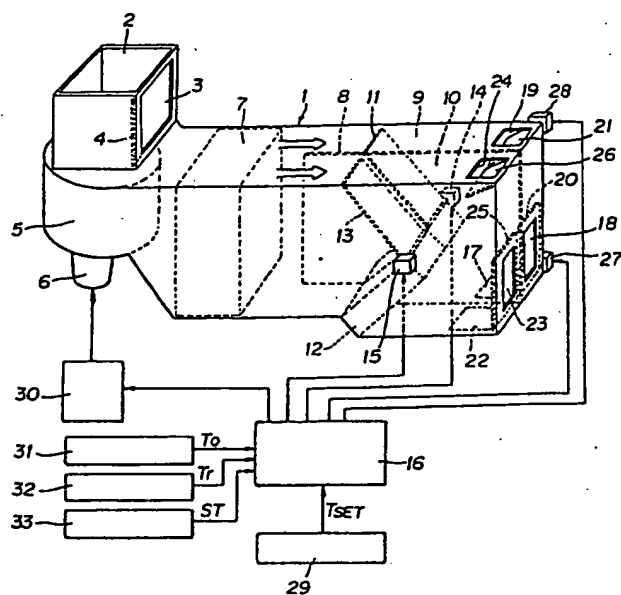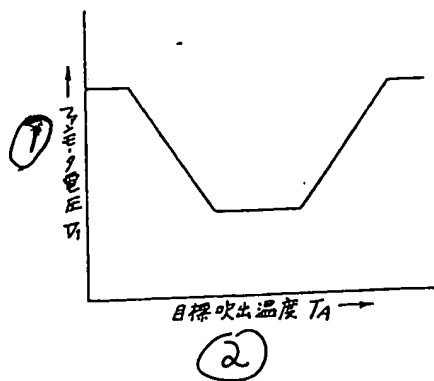T_{AL} Blow-off temperature of the left blow-off port

Figure 1

Figure 2:

1.   Fan motor voltage V_1
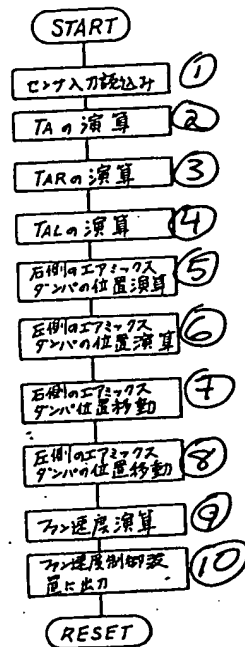
2.   Target blow-off temperature T_A

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Figure 3:

1. Sensor input reading

2. T_A calculation

3. T_{AR} calculation

4. T_{AL} calculation

5. Position calculation of the right air mixing damper

6. Position calculation of the left air mixing damper

7. Position movement of the right air mixing damper

8. Position movement of the left air mixing damper

9. Fan speed calculation

10. Output to the fan speed controller

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(54) AIR-CONDITIONER FOR AUTOMOBILE
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(71) TOYOTA JIDOSHA KOGYO K.K.   **(72)** YUKIO EGAWA
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PURPOSE: To improve the comfortableness both of a drivers seat and an assist-ant's seat by a method wherein the down stream part of an evaporator is divided respectively into air passages for a driver's seat and an assistant's seat, wherein each is provided with temperature regulator, and the temperature on the driver's seat side is lowered and that on the assistant's seat side is raised by a half of the difference between the flow-off air temperature of both seats.

CONSTITUTION: The arithmetic control circuit 16 operates the target blow-off air temperature T_A, the flow-off air temperatures at both seats T_{AR}, T_{AL} by the use of the open air temperature To, the room temperature Tr, the solar heat quantity ST, the preset temperature in the car room and the difference ΔT between the temperature on the driver's seat and on the assistant's seat. At this time, T_{AR} is designated to be lower by one half of ΔT than T_A, T_{AL} is designated to be higher by one half of ΔT than T_A so that the difference between the blow-off air temperatures on both seats makes ΔT. The apertures of the air mixing dampers 11, 13 are controlled by these designated blow-off air temperatures T_{AR}, T_{AL}. The fan 6 is controlled through the fan speed controller 30 so as to meat the target blow-off air temperature T_A. In this structure, secure air-conditioning is kept in the car room to give comfortable conditions for the driver's and assistant.